OCCUPANT CLASSIFICATION SENSE ELEMENT

FIELD OF INVENTION

This invention relates generally to devices for determining the weight of a seated vehicle occupant. More particularly, this invention relates to such a device that operates to isolate and measure a seat occupant's weight from other forces acting on the seat.

BACKGROUND

In modern vehicles, passive safety systems such as airbags are becoming increasingly dependent on data about vehicle occupants. The data is often used by the system to determine each occupant's seating position, mass, and center of gravity. Each occupant's weight is useful in making the determinations.

One method of measuring an occupant's weight is to place a force sensor in the load path between the vehicle floor and the seat structure. The force sensor then provides a signal indicative of a seat occupant's weight. Such sensors, as disclosed in Oestereicher et al., US 6,070,115, are undesirably tall and cause the seat structure to raise from its original position when the sensor is introduced in the load path. In order to return the seat structure to its original height, the seat base, the vehicle floor, or both, must then be redesigned to

lower the seat height to its original level prior to introducing the sensor in the load path.

SUMMARY

It is therefore an aspect of the invention to provide an occupant classification sensor having a low profile to minimize its effect on seat height when installed.

In accordance with this aspect, an occupant classification sense element is provided. The sense element has a body having a center portion, a first attachment portion connected to the center portion by a first flexible beam, and a second attachment portion connected to the center portion by a second flexible beam. First and second strain sensing elements are attached to the first flexible beam and third and fourth strain sensing elements are attached to the second flexible beam. The first, second, third and fourth strain sensing elements cooperate to produce an electrical signal indicative of a force deflecting the first and second flexible beams.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

FIG 1 depicts a schematic diagram in accordance with electrical elements of the present invention;

FIG 2 depicts a side view of an occupant

classification element at rest; and

FIG 3 depicts a side view of an occupant classification under load.

DETAILED DESCRIPTION

The following description is merely exemplary in nature and is in no way intended to limit the invention, its applications, or uses. Other functions may also be implemented as indicated in this specification.

Turning now to Fig. 1, a schematic diagram of electrical aspects of a sense element is shown. Strain sensing elements R_1-R_4 are arranged in a Wheatstone bridge configuration and supplied with excitation voltage at node A. Node C is referenced to ground 8. Nodes B and D provide the differential output across the bridge. Placement of the strain sensors is discussed later herein.

The differential output of the bridge is connected to a signal conditioning circuit, which is preferably embodied in the form of an application specific integrated circuit (ASIC) U1. The ASIC U1 conditions the signal from the differential output of the bridge. Signal conditioning may include functions such as a low-pass filter, thermal compensation, and zeroing an offset in the differential output of the Wheatstone bridge. ASIC U1 has first 16 and second 18 bridge inputs for receiving the signal from the differential output. A signal output 14 provides a

conditioned electrical signal for use by external devices, such as components of a passive safety system. In a preferred embodiment, the signal output is an analog signal, thereby avoiding quantization errors that may be introduced by a digital output. The ASIC U1 receives power through power input 12 and is electrically referenced to ground 8. Connector J1 is attached to the ASIC U1 by cable 20 and may be used to connect the circuit to the external devices. Output terminal 2 provides the conditioned electrical signal, excitation terminal 4 provides voltage to the ASIC U1 and the Wheatstone bridge, and ground terminal 6 provides a connection to ground 8. Both output terminal 2 and excitation terminal 4 are referenced to ground terminal 6.

Turning now to Fig. 2, a side view of a sense element is shown. The sense element is installed in a load path between a seat frame 32 and a floor pan 24. A body 22 has a first attachment portion 42, a second attachment portion 44, and a center portion 46. A first flexible beam 50 connects the first attachment portion 42 to the center portion 46. Similarly, a second flexible beam 48 connects the second attachment portion 44 to the center portion 46. Preferably first and second attachment portions are located opposite each other and coplanar with the center portion 46, located equidistant between them. Body 22 is

preferably formed from a metal having a high yield strength and low modulus of elasticity, such as titanium.

The center portion 46 is attached to a structure, such as floor pan 24. Attachment may be achieved with a bolt 26 threadably engaged to a nut 30, or by other suitable means.

The first and second attachment portions 42, 44, are each connected to seat frame 32 by seat bolts 36 and nuts 38. Each bolt 36 has a flanged head for evenly distributing the bolt-clamping load around its respective mounting portion. A washer is interposed between each mounting portion and its mating section of seat frame 32 to manage the clamping load. Each washer also cooperates with the flange of its mating bolt to provide a uniform strain field throughout their respective attachment portion.

Each flexible beam 48, 50 has strain sensing elements positioned on either the top or bottom of its surface, but not both. Strain sensing elements R4 and R3 of the Wheatstone bridge are positioned on flexible beam 48, with R4 being positioned towards mounting portion 44 and R3 being positioned towards center portion 46. Similarly, strain sensing elements R1 and R2 are positioned on flexible beam 50, with R2 being positioned towards mounting portion 42 and R1 being positioned towards center portion 46. The strain sensing elements are preferably positioned symmetrically about center portion 46. In addition,

positioning the strain sense elements closer to their neighboring mounting portions, or center portion, increases the sensitivity of the sense element. However, doing so increases the possibility of the strain sense elements being biased due to residual strain from clamping forces by bolts 26 and 34. Strain sense elements R1-R4 are preferably a film resistor formed from ruthenium dioxide.

ASIC U1 is positioned on body 22 and preferably potted to protect it from the environment. Cable 20 and connector J1 provide a connection to ASIC U1.

In operation, the weight of an occupant is applied to seat base 32 in a direction towards floor pan 24. With the weight applied, mounting points 42, 44 deflect downward toward the floor pan 24. With mounting points 42, 44 so deflected, flexible beams 48 and 50 will assume an S-shaped curvature. In the regions of strain sense elements R3 and R1, the flexible beams 48 and 50 will be in tension, thereby reducing the resistance of elements R3 and R1 from their nominal values. In the regions of strain sense elements R4 and R2, flexible beams 48 and 50 will in compression, thereby increasing the resistance of strain sense elements R4 and R2 from their nominal values. These changes in resistance will upset the balance of the Wheatstone bridge. The unbalanced voltage at nodes D-B of the bridge is then amplified by ASIC U1 to provide an

indication of the weight applied to the seat base 32. The indication appears as a voltage at pin 2 of connector J1.

Turning to Figure 3, operation of the sense element is shown with a moment force F applied to seat base 32. In this situation, flexible beams 48 and 50 are in compression in the proximity of strain sense elements R3 and R2, thereby decreasing their resistance from their nominal values. Simultaneously, flexible beams 48 and 50 are in tension in the proximity of strain sense elements R4 and R1, thereby increasing their resistance from their nominal values. In this case, the Wheatstone bridge remains in balance and no, or little, net force is indicated by a voltage across nodes D-B. The effect of the moment force on any occupant weight reading is thereby minimized.

The description of the invention is exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.